

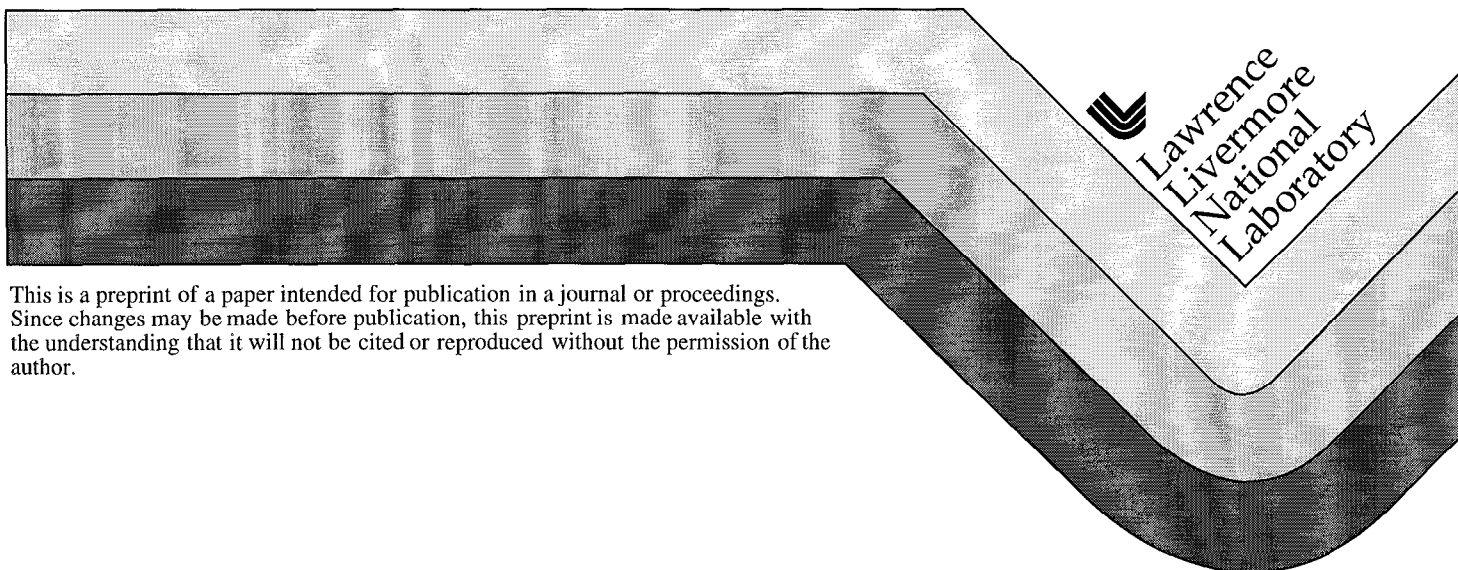
# Portable Data Acquisition System

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# Portable Data Acquisition System

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## **Portable Data Acquisition System**

### **Abstract**

Lawrence Livermore National Laboratory (LLNL) has developed a Portable Data Acquisition (DAQ) System that is basically a laboratory-scale of Program Logic Control (PLC). This DAQ system can obtain signals from numerous sensors (e.g., pH, level, pressure, flow meters), open and close valves, and turn on and off pumps. The data can then be saved on a spreadsheet or displayed as a graph/indicator in real-time on a computer screen.

The whole DAQ system was designed to be portable so that it could sit on a bench top during laboratory-scale treatability studies, or moved out into the field during larger studies. This DAQ system is also fairly simple to use. All that is required is some working knowledge of LabVIEW 4.1, and how to properly wire the process equipment.

The DAQ system has been used during treatability studies on cesium precipitation, controlled hydrolysis of water-reactive wastes, and other waste treatment studies that enable LLNL to comply with the Federal Facility Compliance Act (FFCA). Improved data acquisition allows the study to be better monitored, and therefore better controlled, and can be used to determine the results of the treatment study more effectively. This also contributes to the design of larger treatment processes.

### **Category: R&D**

#### **Products Used:**

LabVIEW 4.1  
NB-MIO-16X  
NB-DIO-32F  
SC-2050 Board  
SC-2052 Board  
SC-2060 Board  
SC-2062 Board  
CB-50 I/O Connector Block  
5B-01 Backplane with associated signal conditioning modules

#### **The Challenge:**

Develop a portable data acquisition (DAQ) system to be used primarily for data gathering but can also be used to control laboratory-scale chemical processes. The system must be flexible enough to allow quick and easy changing of sensors and transmitter frequently along with programming changes.

#### **The Solution:**

Design and fabrication of a compact box that holds the signal conditioning boards, power supplies and terminal blocks with the terminal blocks and signal conditioning boards being easily accessible. This box is then cabled to a computer containing the DAQ boards. The software can be changed just as easily as changing a sensor.

### **Introduction**

Lawrence Livermore National Laboratory (LLNL) has developed a Portable Data Acquisition (DAQ) System to help monitor hazardous, radioactive and mixed waste treatment studies. The system is small enough to sit on a bench top, in a laboratory fume hood, or next to a glove box during laboratory studies, but is also portable so that it can be moved out into the field during pilot-scale studies.



This DAQ system is simple to use. All that is required of the user is some working knowledge of LabVIEW, and how to properly wire the process equipment of interest. Most of the Virtual Instruments (VIs) for the sensors, pumps and valves have already been developed. So by wiring the process equipment up to a given analog or digital channel and supplying the required power, the user can start obtaining legitimate signals quickly.

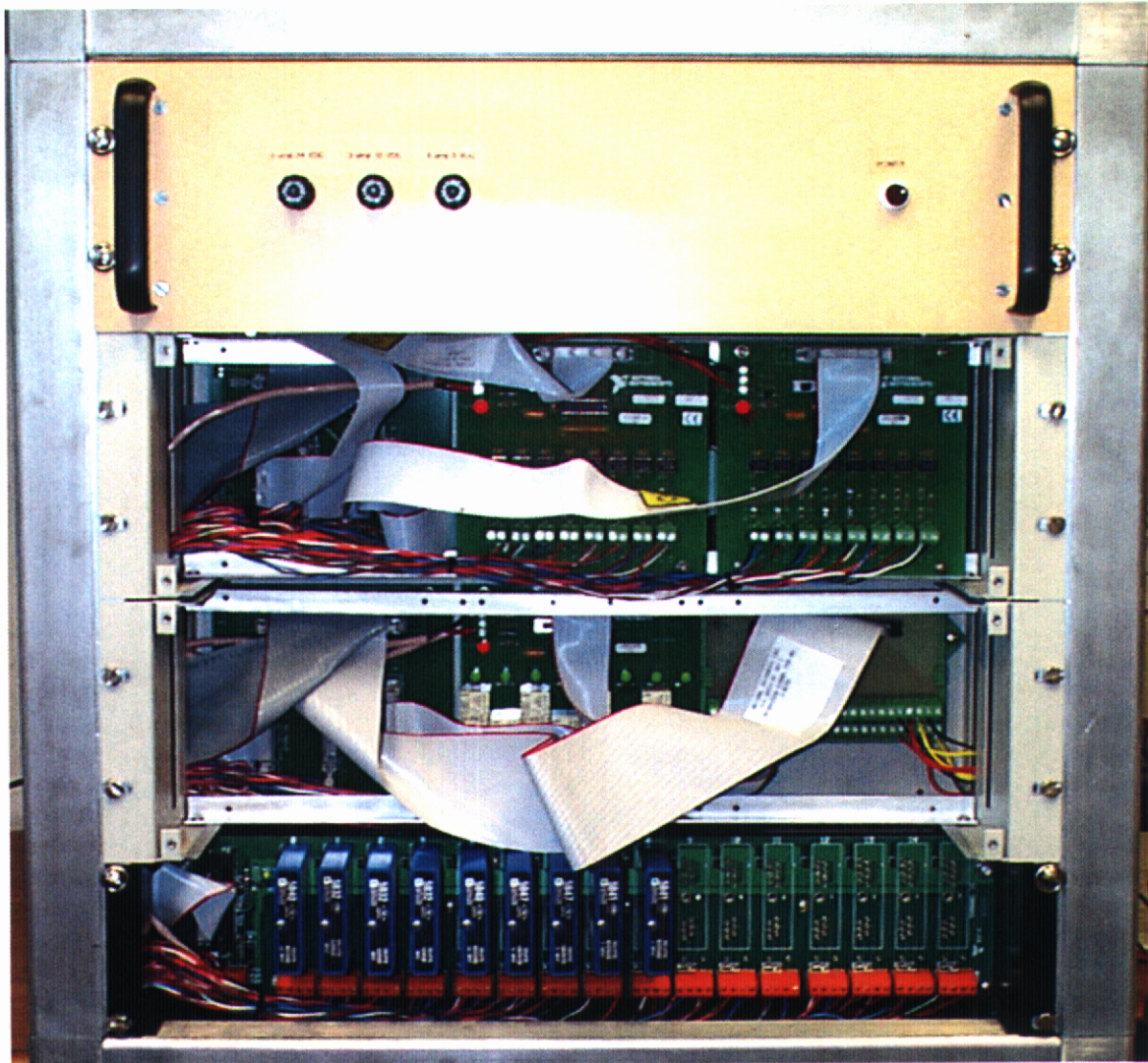
## **The Portable DAQ System**

The DAQ system consists of a computer and a black box. The host computer is an Apple Power Macintosh 8100/80AV that contains an NB-MIO-16X board for multifunction input/output and a NB-DIO-32F board for digital input/output. The MIO board is configured to provide sixteen channels of analog input and eight channels of digital output. The DIO board provides eight channels of digital output and twenty-four channels of digital input. RS-232 communication can also take place through the modem/printer serial ports. The computer also houses a serial board which adds four more serial ports.

The PLC input/output black box chassis is connected to the computer by two four-foot long 50-pin ribbon cables. It is constructed out of aluminum with dimensions of 22" x 22" x 22". The box weighs approximately fifty pounds and has handles on both sides. When plugged into a single standard 110-VAC wall outlet, it supplies +5V, +12V, and +24V DC.

## **The Hardware**

The front of the black box is comprised of four rack mounts and can be seen in Figure I. The top rack mount houses the three power supplies. The lower three rack mounts house the signal conditioning boards, which are all National Instruments boards. There are five signal conditioning boards associated with the NB-DIO-32F data acquisition board and include one SC-2052 cable adapter board, one SC-2062 electromechanical relay board and three SC-2060 digital input boards. For multifunction input/output there is one 5B01 backplane, one SC-2050 cable adapter board, one SC-2062 electromechanical relay board and one CB-50 I/O connector block for the three counter/timers associated with this data acquisition board. The front of the black box was designed to provide easy replacement of the signal conditioning modules, the signal conditioning boards and the fuses associated with the power supplies. All cable and wire connections for the signal conditioning boards are fixed. All connections for sensors, transmitters and power are located on the backside of the black box.

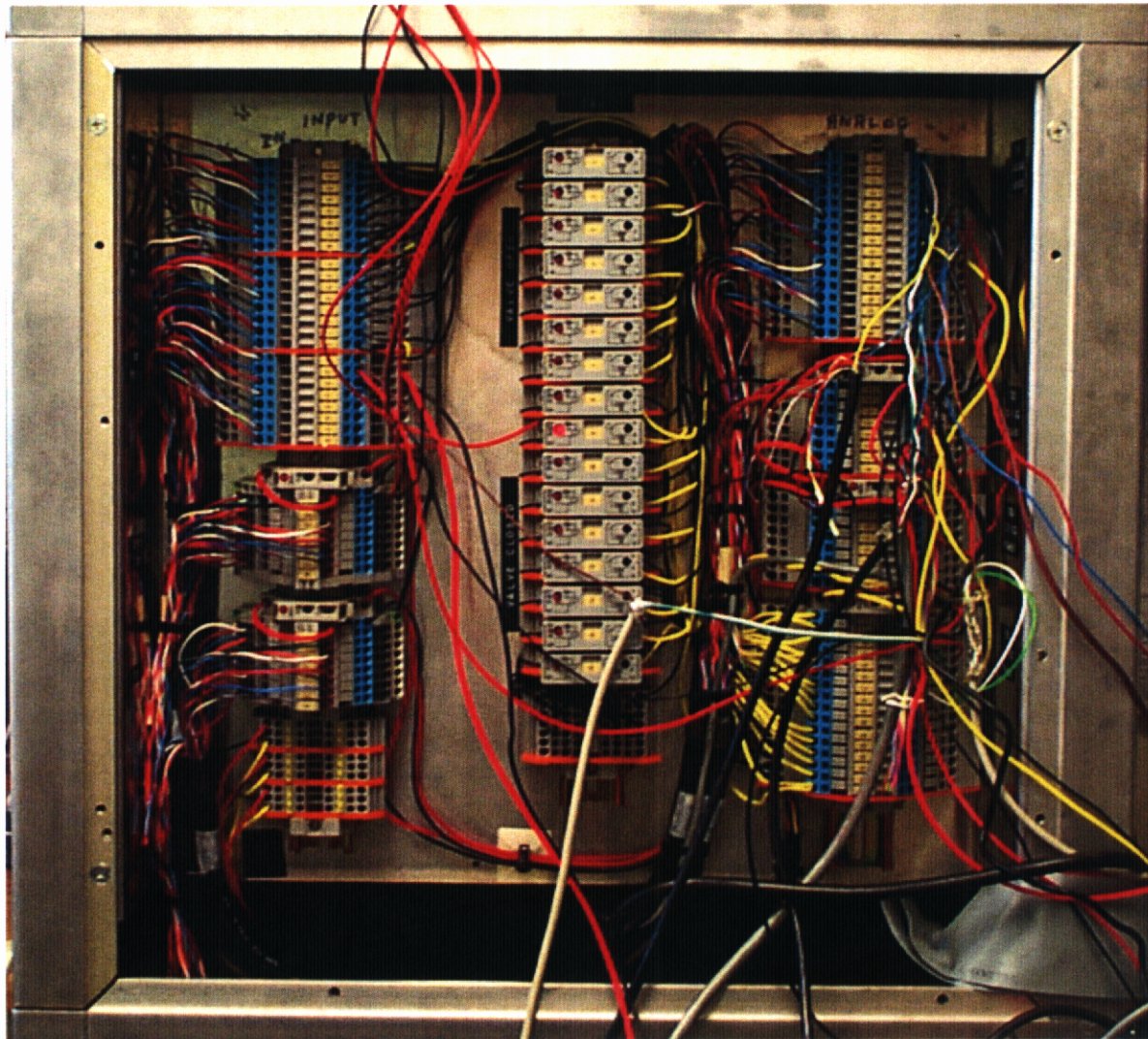


**Figure 1**  
**Front View of Black Box with Covers Removed**

As can be seen in Figure II, the backside of the black box is comprised solely of the various terminal blocks. The terminal blocks, which fit on 35-mm carrier rails, are manufactured by Wago.

For analog input, even though the 5B backplane can supply excitation, this system was designed so that only the analog signal is fed to the 5B backplane through the terminal blocks. Excitation is supplied through the power supply terminal blocks.





**Figure II**  
**Back Side of Black Box**

The terminal blocks for the three power supplies provide about sixteen outputs per power supply. Before the power is connected to these terminal blocks, it passes through fused disconnect terminal blocks. This is done to protect the sensors and circuit boards. These fused terminal blocks have an LED that lights when the fuse is blown.

The system is also capable of controlling eight valve actuators. These valve actuators require +24V-DC power and send back a +24V signal indicating the valve is open, closed or actuating. Only the valve open and closed signals are acquired with this system. A relay/terminal block combination receives the +24V signal and then relays a +5V signal to the appropriate digital input channel.

Sixteen of the digital inputs are specifically for the valve actuators, while the other eight are for generic digital input. The eight digital outputs of the DIO board are specifically for control of the valve actuators, while the eight digital outputs of the MIO board are generic outputs. These digital output terminal blocks also have the fused terminal blocks associated with them. There is also a terminal block section for the counter/timers of the MIO board.

## **Software**

The data acquisition VIs developed are fairly simple. They basically consist of a sequence structure that has three frames. The first frame is where the spreadsheet file is created and where the column headings are written to the file. The second frame is where the sub VIs are referenced, and the data is written to the file. When the user presses a stop button on the panel of the VI, the VI then proceeds to the third frame, where the file is closed, and the VI stops. Developed this way, this system is capable of updating each channel about every second. LabVIEW software provides the capability to sample multiple channels much quicker than is needed for this type of data acquisition, but since the Portable DAQ System has frequently changing assignments, it is a necessity to be able to change sensors and VIs quickly and easily.

## **Conclusion**

The Portable DAQ System has shown itself to be a very powerful tool. By being able to gather much more data than previously capable, it allows all studies to be analyzed in greater detail, and in effect, contributes to the design of a better treatment system. This system would not have been so beneficial if it was not for the fact that it is so easy to learn and use.